Physics question Bank

UNIT-I

CRYSTAL PHYSICS

(Part- A) SHORT ANSWERS

1. What is a space lattice?

Space lattice is an infinite arrangement of points in three dimensions in which every point has an identical surrounding.

2. What is a unit cell ?

It is a smallest geometrical structure of a solid from which the entire crystal structure can be constructed by repetition in three-dimension.

3. Name the seven crystal systems ?

(i) Cubic
(ii) Tetragonal
(iii) Orthorhombic
(iv) Monoclinic
(v) Triclinic
(vi) Rhombohedral
(vii) Hexagonal

4. What is primitive cell ?

A primitive cell is the simplest type of unit cell which contains one lattice point per unit cell.

5. Name the crystal structure of the following :
(a) Gold (b) Germanium (c) Barium (d) Zinc

(a) Gold – FCC (b) Germanium – Diamond cubic (c) Barium – BCC (d) Zinc – HCP

6. Bismuth has a = b = c = 4.47 A and angles α = β = γ= 60^o . What is its crystal structure ?

Given a = b = c = 4.47 A, α = β = γ= 60^o

Since a = b = c and α = β = γ

The crystal structure of Bismuth is Trigonal (or) Rhombohedral

7. What are Bravais lattices ?

There are only 14 ways of arranging points in space such that the environment looks same from each point. i.e., there are 14 possible types of space lattices out of the seven crystal systems. There are 14 space lattices are called as Bravais lattices.

8. Given the value of number of atoms in unit cell of SC, BCC, FCC and HCP.

Type of structure	Number of atom in unit cell
Simple Cubic	1
Body Centred Cubic	2
Face Centred Cubic	4
Hexagonal Close Packed	6

9. Define coordination number ?

It is the number of nearest neighbor atoms that an atom has in the given crystal structure.

10. What are the coordination number for SC, BCC, FCC, HCP and Diamond?

Type of structure	Coordination number
Simple Cubic	6
Body Centred Cubic	8
Face Centred Cubic	12

Hexagonal Close Packed	12
Diamond	4

11. Define atomic radius.

The half of the distance between nearest neighbor atoms in a crystal is known as atomic radius. The atomic radius is denoted by 'r' and it is usually expressed in term of the cube 'a' (lattice parameter).

12. Obtain the formula for atomic radius 'r' in term of lattice constant 'a' for a simple cubic.

In simple cubic structure,

$$2r = a$$

$$r = a/2$$

13. Arrive at an expression for atomic radius in term of lattice parameter for BCC.

$$r + 2r + r = a\sqrt{3}$$

$$4r = a\sqrt{3}$$

$$r = a\sqrt{3}/4$$

14. Derive an expression for atomic radius in term of lattice parameter for FCC.

$$R + 2r + r = a\sqrt{2}$$

$$4r = a\sqrt{2}$$

$$r = a\sqrt{2}/4$$

15. Define packing factor. What is its unit?

It is the ratio of the volume of atoms in the unit cell to the volume of the unit cell.

16. Calculate packing factor in the case of simple cubic structure.

$$Packing\ factor = \frac{Volume\ occupied\ by\ the\ atoms\ in\ a\ unit\ cell}{Voilme\ of\ a\ unit\ cell}$$

$$\frac{1 \times (¾)\pi r^3}{a^3}$$

For SC, $r = a/2$

$$\therefore Packing\ factor = \frac{1 \times [4/3]\pi r^3}{(2r)^3}$$

$$PF = \frac{4/3\pi r^3}{(2r)^3} = \frac{4/3\pi r^3}{2^3 r^3} = \frac{\pi}{6}$$

PF = 52%

17. Calculate packing factor of body centred cubic crystal.

$$Packing\ factor = \frac{Volume\ occupied\ by\ the\ atoms\ in\ a\ unit\ cell}{Voilme\ of\ a\ unit\ cell}$$

$$= \frac{1 \times [4/3]\pi r^3}{a^3}$$

Number of atom per unit cell = 2

For BCC, side of unit cell a = $\frac{4r}{\sqrt{3}}$

$$r = \frac{\sqrt{3}a}{4}$$

$$Packing\ factor = \frac{2 \times 4/3\ \pi r^3}{[4r/\sqrt{3}]^3} = \frac{8/3\pi r}{4^3 r^3/(\sqrt{3})^3}$$

$$\frac{8/3\pi r^3}{64r^3/\sqrt{3}\times 3} = \frac{\sqrt{3\pi}}{8} = 0.68$$

PF = 68%

18. ***What are crystalline materials? Give example.***

Crystal materials are materials in which the atoms are arranged in an orderly fashion through out in a three dimensional pattern . Example : Copper, silver.

19.What is a crystal ?

A Crystal is a three dimensional solid composed of a periodic and regular arrangement of atoms .

20. What are Miller indices?

A set of three number to designate a plane in a crystal is known as Miller indices of the concerned plane.

21. Give the expression for interplanar spacing for a cubic interms of lattice constant and Miller indices.

Interplanar spacing d = $\frac{a}{\sqrt{h^2+k^2+l^2}}$

a- Lattice constant
h,k,l – Miller indice

22. Sketch the (110) plane in a cubic system.(Diagram)

23. Sketch (111) plane for a cubic crystal.(Diagram)

24.What are lattice points?

The points in the space to represent position of atom or group of atoms of the crystal are called lattice points.

25.What are the advantages of Czochralski method?

(I)Growth from free surface.

(II)Growth of large oriented single crystals

(III)Convinent chemical composition

(IV)Control of atmosphere.

PART-B

1.Define the terms 'Atomic radius and packing factor.Calculate the above for SC, BCC, and FCC structures.

2.Describe the structure of a HCP crystal. Give details about its atomic radius , atomic packing and axial ratio.

3.What is packing ? Prove that the packing factor of HCP is 0.74.

4.(i)Show that the atomic packing factor of FCC and HCP are the same .

(ii)What are Miller indices? Explain how they are determined.

5.Describe Bridgman method of crystal growth. Mention its advantages and disadvantages.

6.Explain Czochralski method of growing crystal. Mention merits and demerits.

7.Describe the solution growth of crystal and list out its advantages and disadvantages.

8.Explain the vapour growth techniques of growing crystals.

UNIT II

PROPERTIES OF MATTER & THERMAL PHYSICS
(PART- A)

1. ***What is elasticity?***

   The property of the body to regain its original shape or size, after the removal of deforming force is called elasticity.

2. ***What are elastic bodies?***

   Bodies which regain its original shape or size after the removal of deforming force are called elastic bodies

3. ***Define stress and its unit.***

   The restoring force or recovering force per unit area set up inside the body is called the stress.

   This restoring force is equal and opposite to the applied force F. Therefore, stress is also defined as

   The deforming force applied per unit area of the body is called stress.

   i.e., Stress = $\frac{Deforming\ Force}{Area} = \frac{F}{A}$

S.I. unit of force is newton (N)

And that of area is meter^2 $(m)^2$

$\therefore$ *SI unit of stress =* $\frac{newton(N)}{metre^2\ (m)^2}$ *= N/m² (or) Nm⁻²*

4. What are the type stresses?

It is found that a deforming force may change the length or the shape of the body or the volume. Accordingly, there are three types of stresses namely (i) Longitudinal or normal stress (ii) Shearing or tangential stress (iii) Volume or compressive stress.

5. Define strain and its unit.

The change in dimension or shape of a body due to the deforming force is called strain.

It is measured by the ratio of change in dimension to the dimension i.e.,

$$Strain = \frac{Change\ in\ dimension}{Orginal\ dimension}$$

6. What are the types of strains?∞∞

According to the changes take place in length, area (shape) and volume, there are three types of strains namely,

(i) Linear strain (change per unit length)

(ii) Shearing strain (change per unit area)

(iii) Volume or bulk strain (change per unit volume)

7. State Hooke's law.

It states that ***"within elastic limit, the stress developed in the body is directly proportional to the strain produced in it" .***

$$Stress \propto Strain$$

$$Stress = Constant \times Strain$$

$$\frac{Stress}{Strain} = E\ (constant)$$

In other word, the ratio between stress and strain is constant .

This constant of proportionality is called the co-efficient of elasticity or modulus of elasticity.

8. What are the types of moduli of Elasticity?

(i) Young's modulus of elasticity, corresponding to longitudinal strain.

(ii) Rigidity modulus or shear modulus corresponding to shearing strain.

(iii) Bulk modulus or volume corresponding to volume strain.

9. Define Young's modulus of elasticity.

Within the elastic limit, the ratio of longitudinal stress to longitudinal Strain is called the Young's modulus of elasticity.

It is denoted by the letter Y.

Young's modulus of elasticity (Y) = $\frac{Longitudinal\ stress}{Longitudinal\ strain}$

Unit: SI unit of stress is Nm^{-2} and strain has no unit. Therefore, SI unit of Young's modulus is Nm^{-2}.

10.Define rigidity modulus and mention its unit.

With in the elastic limit of a body, the ratio of the tangential stress to shearing strain is called rigidity modulus.

It is denoted by the letter n,

Rigidity modulus (n) $= \frac{Tangential\ stress}{Shearing\ strain}$

Unit : SI unit of rigidity modulus is Nm^{-2}

11.What is stress – strain diagram?

A graph plotted between strain along the X- axis and stress along the Y-axis as stress – strain diagram

12.Define bending moment of a beam.

The moment of the couple due to the static reactions (restoring couple) which balances the external couple due to the applied load is called ***bending moment****.*

13.What is uniform bending ?

The beam is loaded uniformly on its both ends, the bent beam forms an are of a circle. The radius of curvature of the bent beam is constant for give load. This type of bending is called uniform bending.

14. What is I Shape Girder?

A girder is a metallic beam supported at its two ends by pillars or on opposite walls. It should be so designed that it should not bend too much or break under its own weight. The cross section of beam is in the from of letter I.

15.What are advantages of I shape girder?

a) This type of cross- section provides a high bending moments and a lot of materials is saved.

b) I form of girders are made of steel as they have high young modulus.

16. What is cantilever?

A cantilever is a beam fixed horizontally at one end and loaded at the other end.

17. Define heat conduction.

Conduction is the process of transmission of heat from one point to another through substance (or some medium) without the actual motion of the particles.

18. Define coefficient of thermal conductivity and mention its unit .

It is defined as the quantity of heat conducted per second normally across unit area of cross- section per unit temperature difference per unit length of the material.

Its unit is watts / metre/ Kelvin($Wm^{-1}K^{-1}$)

19.What is basic principle behind lee's disc method in determine thermal conductivity of bad conductor?

At steady state

{ Head conducted through The bad conductor per second = Amount of heat lost per second by the disc

From this n thermal conductivity of the bad conductor is calculated.

20.What are the characteristics of good and bad conductors?

	Good Conductors	*Bad conductors*
1.	*They have high electrical& Thermal conductivity*	*They have very low electrical and thermal conductivity.*
2.	*They can be easily heated or cooled*	*They cannot be easily heated or cooled*
3.	*Examples: Metals like iron, Copper.*	*Examples: Non metals like glass. Wood.*

21.What is thermal resistance?

The thermal resistance of a body is a measure of its opposition to the flow of heat through it.

22. What is radial flow of heat ?

In this method, heat flows from the inner side towards the other side along the radius of the spherical shell or cylindrical shell. This method is interesting because there is no loss of heat as in the other methods.

23.Define Newtion 's law of cooling.

It states that the rate at which a body loses heat is directly proportional to the temperature difference between the body and that of the surroundings.

24. What are limitations of Newton's law of cooling?

- *The temperature difference between the hot body and surrounding should be low.*
- *The heat loss is only by radiation and convection*
- *The temperature of hot body should be uniform throughout.*

25.Define Bulk modulus and mention its unit.

With in the elastic limit of a body, the ratio of volume stress to volume strain is called bulk modulus of elasticity".

It is denoted by the letter K

Bulk modulus (K)= $\frac{Volume\ stress}{Volume\ strain}$

Unit : SI Unit of bulk modulus is Nm^{-2}

PART -B QUS & ANS

1.Derive an expression for the internal bending moment of a beam in terms of radius of curvature.

2. What is cantilever? Obtian an expression for the depression at the loaded end of a cantilever whose other end is fixed assuming that its own weight is not effective in bending.

3.Derive an expression for the elevation at the centre of a beam which is loaded at both ends. Describe an experiment.

4.Write a note on stress strain diagram. Explain the factors affecting the elasticity.

5.Derive the equation for one dimensional flow of heat and solve it under steady state condition .

6.Describe with relevant theory the method of determining the coefficient of thermal conductivity of a bad conductor by Lee's disc method .

7.Derive an expression for the quantity of heat flow through a metal slab whose faces are kept at two different temperatures. Use this expression to determine the thermal conductivity of a bad conductor by Lees's disc method.

8.Describe a method of determining thermal conductivity of rubber